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TITLE   A Cray/VAX Interactive Graphics System

AUTHOR(S)   Donald (Leroy) Willerton

Los Alamos
Los Alamos National Laboratory
Los Alamos, New Mexico 87545

A CRAY/VAX INTERACTIVE GRAPHICS SYSTEM

Donald Willerton*
Los Alamos National Laboratory
Los Alamos, New Mexico

ABSTRACT

A new graphics system has been brought into production at Los
Alamos National Laboratory that interfaces user codes running on
the Cray-1 computers with an Evans and Sutherland Multi Picture
System high-speed, high-resolution graphics workstation. The
system is described from three points of view: hardware, software,
and software functions. Special emphasis is placed on the use of
detached processes, global sections, and event flag communication.

INTRODUCTION

An interactive graphics system, called the Cray/VAX
interactive graphics system, has been brought into
production at Los Alamos National Laboratory that
provides Cray users with a high-speed, high-resolution
interactive graphics workstation. This workstation is
accessed through a series of hardware components that
includes a network file transport computer, a high-speed
data channel, a VAX 11/780, and a graphics processor.
Multiple layers of software permit VAX transparency to
the user, yet provide a secure, multi-tasking environment.
Extensive use is made of detached processes, subprocesses,
global sections, and event flags. Currently, the graphics
workstation used at Los Alamos is an Evans and
Sutherland Multi Picture System (MPS) (see Figure 1),
but any graphics device may be supported.

The graphics system can be dealt with by looking at the
system in three different perspectives: the hardware, the
software, and the software functions. Establishing the
concept of each of these provides insight into the basic
simplicity of the system, though it is complex in detail.

HARDWARE

To establish the concept of the hardware, use Figure 2 to
follow the data, without regard to format, from the Cray
resident code to the MPS display. The data from the
Cray is moved by the file transport machine (the SEL)
from the Cray disks to the SEL disks. The SEL then
moves the data, through the serializer-modem
combinations, to the VAX, where it goes by UNIBUS
connection to the VAX memory. From there it is m ed
to the MPS processor for processing and display.
Information flow from the VAX to the Cray will follow
the same route but in the opposite direction. The
measured rates from the Cray program to the VAX
memory is effectively one-half megabit per second.

Figure 1. The Evans and Sutherland Multi Picture
System graphics workstation.

Figure 2. Hardware diagram.

SOFTWARE

To establish the concept of the software, again follow the data from generation to display this time using Figure 3. All graphics at Los Alamos use the Common Graphics System (CGS) control software. This is a Los Alamos-created, device-independent, CORE-based graphics system that either can send data directly to a display device (using a software module called a device driver) or can create an intermediate, device-independent data file (called a metafile) that is then postprocessed by a number of postprocessors. The postprocessors use output medium as varied as 35-mm color film or 42-in. flatbed photostatic plots.

With this system in place, there are three ways to create suitable data for the MPS. First, the CGS metafile itself can be used with a CGS-to-MPS converter (resides on the VAX) that uses the MPS library. Second, a library on the Cray can be used that emulates the CGS graphics primitives software and will produce an MPS-formatted data file; this file is called an untransformed display list (UDL) and is discussed later. Third, a device driver that conforms to the CGS control software specifications can be used with an MPS emulation library to produce a UDL.

Figure 3. Software diagram.

Regardless of the data format, a file with the data is sent to the VAX. A VAX process, referred to as the file transport module, receives the file and places it into a global section. The file transport module is always active in a "receive state" — the established protocol demanding that the Cray initiate any communication.

In handling the file, a header is removed by the transport module. This header will contain a command word that indicates the particular subprocess to be used to process the data. This means that the Cray not only initiates the communication but also actually controls the VAX process selection. Also, at this point, the file transport module performs security verification of the header encoding, confirming security level, user number, network paths, and other information required by the classification of the data.

When the file transport module is ready to begin the indicated process it matches the header subprocess name to a VAX file descriptor of the executable subprocess image. This image is then created as a detached process. The process, separately and asynchronously with the file transport module, performs its particular function using the data in the global section. If the data is a CGS metafile, a translation is performed to make the data into a UDL. A UDL is a graphics file containing the graphics data preceded by MPS operation codes that define the nature of the data. The UDL is sent by a single command to the processor memory in the MPS processor console. The UDL is then operated on by different units in the processor and put into a display buffer, which is used to refresh the display.

If the data is already a UDL, then the process does no translation and performs only a "send the UDL" command. An alternate to sending the UDL directly to the MPS processor in either of the above cases is to store the UDL in the VAX memory as an ordinary file. The file is given a special name and sequence number and can be retrieved later.

The communication that permits these detached processes to work with the transport module is accomplished by event flags. The file transport module looks at a variety of event flags that allow it to be either processing or not processing or allow it to negotiate communication, as when interactive devices are used with the MPS display. This adherence to established event flags is the same through the different processes so that the flags retain the same meaning in any of the modules.

SOFTWARE FUNCTIONS

To establish the concept of the software from a functional point of view, look at Figure 3. On the Cray, the user has to do one of three things. First, he does nothing to his code (other than ordinary selection of metafile output) and then postprocesses the CGS metafile using a Cray utility that sends the file over to the MPS frame by frame. He controls the display of the frames as well as the storage of the frames in memory by using function switches attached to the MPS processor. Second, he does nothing to his source code but reloads his compiled code with a CGS emulation library that produces and ships a UDL frame by frame. Third, he may change his code to make calls to a CGS-MPS device driver (entails minor changes only), which then generates and ships a UDL frame by frame.

The functions on the VAX match whatever needs to be done: direct display, translation and display, translation and save, or direct save.

If a message is sent instead of graphics information, a number of processor functions can be controlled by the Cray. For example, to replay frames of graphics saved in VAX memory, the Cray sends a message that is a header only. The command word is the name of a subprocess that will, when activated, move the frames into a global section and then initiate a "send the UDL" command. This mode of operation is used frequently and will produce a display of saved frames at a rate of from 8 to 14 frames per second, which achieves an appearance somewhat like a movie.

The message from the Cray may also direct itself into a command mode, using a DCL command line. The utility on the Cray can format a DCL command and place it into the global section on the VAX; then a particular detached process will use the line in the global section in a SYS$CREPRC call (see Figure 4) to execute that command. In this manner, the Cray utilities may provide functions like DELETE file, LIST file, RENAME file, and others. This provides a high degree of transparency for the VAX, while providing simple means for acquiring needed functions for the Cray user of the MPS.
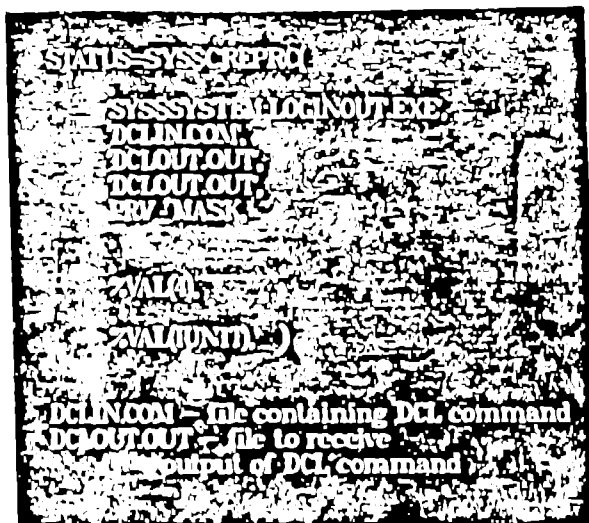

Figure 4. The SYS$CREPRC call.

SUMMARY

The Cray/VAX interactive graphics system now in use at Los Alamos accomplished its projected goals and then added a few features not originally planned. Experience has shown that the two most used features of the MPS are the CGS emulation library (because it contains a three-dimensional capability that is an extension of the regular CGS library) and the fast replay of stored graphics frames. The Cray/VAX system has been very reliable and relatively resilient to long-term use. Future enhancements include using higher speed modems in the current configuration, multiple stations (the MPS provides for up to four graphics stations for each processor), and color.